The α-particle dose of the solubility threshold for detrital epidote-group grains from the Yangze River delta

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The epidote-group minerals are common accessory phases in silicate rocks. These calc-silicate minerals may contain substantial quantities of Th, and concomitantly U. The radioactive decay of ^{232}Th, ^{238}U, ^{235}U to their daughter nuclides results in the radiation-induced transformation from a periodic to an aperiodic structure termed metamictization [1]. Metamictization of epidote-group minerals can increase their solubility and thus these minerals can be important sources of Ca in pore and stream waters that drain silicate terranes [2]. On geologic timescales, dissolved Ca and bicarbonate ions from silicate mineral dissolution are carried by streams to the oceans where they are sequestered in Ca-carbonate minerals [3]. Therefore, the weathering of metamict epidote-group minerals is capable of consuming atmospheric CO_2 and potentially influencing the long-term global climate.

The extent of epidote-group mineral metamictization is a function of age, and Th and U content, which together yield the α-particle dose of the grain [4]. To determine the solubility threshold of epidote-group minerals, the α-particle dose of grains from the Yangtze River delta in China have been calculated. These detrital grains are resistant to chemical weathering and persist into fluvial sediments. Delta sediments from such a large river system provide a suite of epidote-group minerals that approximate the compositional range and radiation damage commonly observed in nature for grains resistant to dissolution. The grain(s) with the highest α-particle dose thus reflect the solubility threshold for the epidote-group minerals.

The Th, U, and Pb isotopic compositions of each grain were measured by laser ablation-inductively coupled plasma-mass spectrometry. ^{232}Th-^{208}Pb ages were corrected for common Pb using an iterative technique [5]. End-member epidote grains contain sufficiently low Th and U concentrations to prevent quantification of an α-particle dose, explaining, at least in part, why they are so resistant to chemical weathering. End-member allanite grains are relatively radioactive, reflect at least four sources of allanite to the delta, and yielded a maximum α-particle dose of ~3.6 x 10^{15} α-decays mg^{-1}. This dose compares very favorably with that of ~3.5 x 10^{15} α-decays mg^{-1} reported for Amazon detrital zircons [6].

[1] Deer et al. (2001) *Rock-Forming Minerals (2nd Edition), Disilicates and Ring Silicates* **1B**. [2] Price et al. (2005) *American Mineralogist* **90**, 101-114. [3] Berner et al. (1983) *American Journal of Science* **283**, 641-683. [4] Holland & Gottfried (1955) *Acta Crystallographica* **8**, 291-300. [5] Chew et al. (2011) *Chemical Geology* **280**, 200-216. [6] Balan et al. (2001) *American Mineralogist* **86**, 1025-1033.

Light activation of steady state copper uptake in marine diatoms

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Marine diatoms of the Thalassiosirales use either a Cu-containing plastocyanin (PC) or an Fe-containing cytochrome (cyt) c_6 to transfer electrons from cyt b_6f to photosystem I in the light reactions of photosynthesis. Growth assays confirm that the PC-containing strains require higher concentrations of Cu for cell division and contain roughly 2-3 times more cellular Cu (30.8 fmol Cu' L^{-1}) than strains with cyt c_6. Under steady state conditions, Cu uptake rates are a linear inverse function of Cu-limited growth rates and not significantly different among PC and cyt c_6-containing strains. Thus, despite having greater cellular demand for Cu, diatoms that use PC are unable to acquire extra Cu. In the presence of high light, however, Cu uptake rates of PC-containing species are increased by 2-10 fold, suggesting that Cu acquisition is somehow light-activated. Steady state Cu uptake rate is proportional to irradiance at both high and low Cu concentrations (Fig. 1). We are currently examining how light affects extracellular Cu(II) reduction in a number of PC and cyt c_6-containing *Thalassiosira* species.

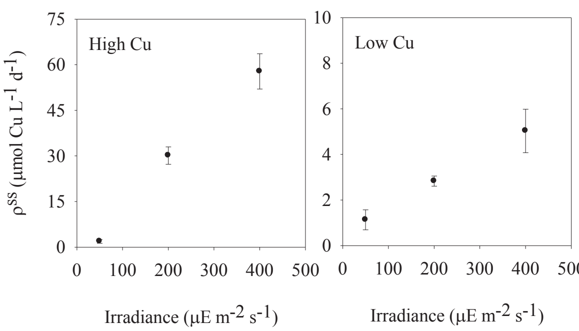

Figure 1: Steady state Cu uptake rate of *Thalassiosira oceanica* normalized to cellular volume as a function of growth irradiance. Values are means of 3-5 replicates and error bars ± 1 std.